

APPLICATION FOR UNITED STATES LETTERS PATENT

INVENTOR(S): Takehiro IKEDA  
Ichiro OKAJIMA  
Narumi UMEDA

INVENTION: MOBILE COMMUNICATION SYSTEM,  
AND LOCATION REGISTRATION  
METHOD OF MOBILE STATION,  
RESOURCE CONTROL METHOD AND  
RECORDING MEDIUM IN MOBILE  
COMMUNICATION SYSTEM

S P E C I F I C A T I O N

09992585-110601  
T0907T-585E6660

SUB  
A1

This application is based on Patent Application No. 2000-343886 filed November 10, 2000 in Japan, the content of which is incorporated herein by reference.

5

## BACKGROUND OF THE INVENTION

## FIELD OF THE INVENTION

10 The present invention relates to a mobile communication system, and a location registration method of a mobile station, a resource control method and a recording medium in the mobile communication system, and more particularly to a mobile communication system that provides the mobile station with radio communication services from a base station via a radio channel, and a location registration method of a mobile station and a control method of the number of radio channel, and a recording medium that records programs  
15 of these methods in the mobile communication system.  
20

## DESCRIPTION OF THE RELATED ART

In a mobile communication system, a mobile station  
25 communicates with a base station via a radio channel. Thus, it is necessary for the system to make a decision as to which base station must transmit a signal to the

0999355-110604

mobile station when the base station carries out a  
downlink transmission to the mobile station. Thus, to  
identify the location of the mobile station, the  
conventional mobile communication system establishes  
5 a plurality of location registration areas, and manages  
the location registration areas in which mobile  
stations are present. This is called location  
registration. Here, the location registration area  
can be an area (cell) covered by a single base station,  
10 or an area consisting of a plurality of cells.

In the location registration method of the mobile  
station in the conventional mobile communication  
system, every time the mobile station moves across the  
location registration areas, the mobile station  
15 updates its registration under its own initiative (on  
the side of the mobile station). Therefore, even if  
the mobile station knows its own visiting location at  
a certain time in the future, it cannot make the  
location registration of the visiting location in  
20 advance. As a result, it is difficult to carry out  
flexible location registration control.

#### SUMMARY OF THE INVENTION

25 An object of the present invention is to implement  
flexible and effective location management of a mobile  
station by providing a location management agent acting

for the mobile station to conduct the location registration, and to implement flexible and effective resource control by providing a resource management agent.

5           A mobile communication system in accordance with the present invention includes a location management agent for conducting a new location registration and a registration update of a mobile station in a prescribed service area, and comprises schedule  
10   notifying means for sending moving schedule information at a particular time from the mobile station to the location management agent in advance and a location registration database provided in the location management agent for registering the moving  
15   schedule information about the mobile station at the particular time such that the moving schedule information has correspondence with a scheduled destination location registration area. Wherein the location management agent, referring to the location  
20   registration database, updates the location registration area of the mobile station in the prescribed service area at the particular time.

          A location registration method of a mobile station in a mobile communication system in accordance with the  
25   present invention includes a location management agent for conducting a new location registration and a registration update of the mobile station in a

00003505-110601  
FOUO 505060

09093585-110601  
T090T-585660

prescribed service area. The method comprises a first step of sending moving schedule information at a particular time from the mobile station to the location management agent in advance, a second step of  
5 registering, in a location registration database provided in the location management agent, the moving schedule information about the mobile station in correspondence with the particular time and a scheduled destination location registration area at the  
10 particular time and a third step of updating the location registration area of the mobile station in the prescribed service area at the particular time by the location management agent with referring to the location registration database.

15 A resource control method in a mobile communication system in accordance with the present invention conducts a new location registration and a registration update of a mobile station in a prescribed service area. The method comprises a first step of  
20 registering moving schedule information about the mobile station in a location registration database of a location management agent such that the moving schedule information has correspondence with moving schedule time, and an original position and a scheduled  
25 destination location registration area of the mobile station at the time, and a second step of adaptively controlling the number of the radio channels to be

assigned to the location registration area by a  
resource management agent installed in each location  
registration area in the prescribed service area in  
response to a command sent from the location management  
5 agent, in accordance with the moving schedule  
information registered in the location registration  
database.

09031505-110501  
10 A recording medium in accordance with the present  
invention records a computer readable program of a  
location registration method of a mobile station in a  
mobile communication system including a location  
management agent for conducting a new location  
registration and a registration update of the mobile  
station in a prescribed service area. The recording  
15 medium causes a computer to execute the first step, the  
second step and the third step in the above described  
location registration method.

An alternate recording medium in accordance with  
the present invention records a computer readable  
20 program of a resource control method in a mobile  
communication system conducting a new location  
registration and a registration update of a mobile  
station in a prescribed service area. The program  
causes a computer to execute the first step and the  
25 second step in the above described resource control  
method.

The mobile communication system, the location



Fig. 3 is a schematic diagram illustrating a signal format of moving schedule information transmitted from a mobile station to a location management agent;

Fig. 4 is a flowchart illustrating a flow of the location registration control in the embodiment 1;

Fig. 5 is a diagram showing a system configuration of an embodiment of radio resource control using the moving schedule information the location registration agent in accordance with the present invention possesses;

Fig. 6 is a schematic diagram illustrating the moving schedule information of individual mobile stations the location management agent has in the location registration database;

Fig. 7 is a flowchart illustrating a flow of radio resource control in an embodiment 2; and

Fig. 8 is a diagram showing a system configuration of the radio resource control in the embodiment 2.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The invention will now be described with reference to the accompanying drawings.

### EMBODIMENT 1

Fig. 1 is a diagram showing a system configuration of an embodiment 1 of the location registration of a mobile station in a mobile communication system using



a radio channel in accordance with the present invention.

In Fig. 1, reference numerals #0, #1, ..., #N each designate a location registration area, the reference symbol MS#1 designates a mobile station, and the reference numeral 10 designates a location management agent. Each location registration area may comprise a plurality of base stations, or a single base station. For the simplicity of explanation, only one mobile station is shown in Fig. 1. The location management agent 10 comprises a location registration database 20 as shown in Fig. 2, and the downlink data routing in the network is carried out with looking up the location registration database 20.

In the present embodiment, it is assumed that the mobile station MS#1 visiting the location registration area #1 at the present time is scheduled to move into the location registration area #N at a future time T. The mobile station MS#1 sends the moving schedule information to the location management agent 10 using the signal format as shown in Fig. 3, thereby notifying the location management agent 10 of the scheduled destination. The location management agent 10, which can be implemented in the form of software, has a function of making a decision from the received moving schedule information as to which one of the location registration areas #0, #1, ..., #N corresponds to the

scheduled destination.

As shown in Fig. 3, the moving schedule information of the present embodiment includes the location registration agent address 31, the mobile station address 32, a location registration command 33, and a moving time 34 to a new location registration area, and a destination address 35 at the time. In this format, the scheduled destination of the mobile station MS#1 can also be represented by using a telephone number or information about its latitude and longitude instead of the destination address 35.

According to the moving schedule information with the foregoing format, which is received from the mobile station MS#1, the location management agent 10 sets the moving schedule flag 23 in the location registration database 20 (Fig. 2), and makes an additional registration of a moving time 24 and a destination registration area 25. Then, it updates the location registration database 20 at the time T. In other words, it rewrites the location registration area 22 from "#1" to "#N" at the time T, thereby making the new location registration.

Fig. 4 shows a flow of the location registration control in the present embodiment when the mobile station MS#1 moves from the visiting area to the location registration area MS#N according to the scheduled. The control enables the location

management agent 10, which carries out the location management in place of the mobile station, to conduct the registration in the location registration database before the movement of the mobile station, and to update  
5 the location registration database at the scheduled time. Thus, it can implement flexible and effective location management of the mobile station.

Although the location registration is made only at the time future T in the foregoing example, the  
10 present invention is not limited to it. For example, when the mobile station travels by a vehicle whose moving pattern is known in advance, and passes through a plurality of location registration areas until it arrives at the final destination, such control is  
15 possible that makes the location registration in the course of the movement. In this case, repeating the control as illustrated in Fig. 4 by (N+1) times, where N is the number of the location registration areas passed by, can implement the flexible and effective  
20 location management of the mobile station.

Incidentally, the mobile station can comprise schedule management software so that the schedule management software can automatically transmit the moving schedule information about the mobile station  
25 to the location management agent 10 to notify it of the scheduled destination.

EMBODIMENT 2

Fig. 5 is a diagram showing a system configuration of an embodiment 2 of the radio resource control using the moving schedule information possessed by the location registration agent in the mobile

5 communication system in accordance with the present invention. In the present embodiment, it is assumed that each location registration area controls the number of the radio channels, and has a resource management agent (RMA).

10 Fig. 5 shows the number of mobile stations and the number of radio channels (time slots, frequencies, codes etc.) in the location registration areas #0, #1, ..., #N at the time T. In Fig. 5, the reference symbols MS#1, ..., MS#6, MS3#N, MS3#N+1 and MS3#N+2 each  
15 designate a mobile station; and RMA50<sub>0</sub>, RMA50<sub>1</sub>, ..., RMA50<sub>N</sub> each designate a resource management agent. In the present embodiment, it is assumed that one channel per mobile station is assigned to each location registration area for the simplicity of explanation.

20 Fig. 6 is a schematic diagram illustrating the moving schedule information about the individual mobile stations the location management agent 10 has in the location registration database.

The moving schedule information as illustrated in  
25 Fig. 6 indicates that the mobile station MS#2 is scheduled to move from the location registration area #0 to #1, and the mobile station MS#3N is scheduled to

move from the location registration area #3N to #1 within a predetermined time period  $T_{window}$  after a radio channel assignment update period  $T_{ch}$  has elapsed from the time  $T$ , where  $T_{window}$  is greater than zero and  
5 equal to or less than  $T_{ch}$ .

According to the moving schedule information, the location management agent 10 carries out the location registration control as illustrating in Fig. 7, which establishes the number of the mobile stations and the  
10 number of channels as shown in Fig. 8 at the time  $T + T_{ch}$ .

Here, it is assumed that the radio channels assigned to the location registration areas #0, #1, ..., #N are determined by the number of the mobile stations  
15 that are scheduled to be present in the location registration areas #0, #1, ..., #N from the time  $T + T_{ch}$  to the time  $T + T_{ch} + T_{window}$ , in accordance with the moving schedule information.

In the present embodiment, the individual location  
20 registration areas #0, #1, ..., #N are each assigned three channels at a particular time  $T$  (Fig. 5). In Fig. 7, according to the moving schedule of the individual mobile stations during the time period  $T_{window}$  from the time  $T + T_{ch}$  as illustrated in Fig. 6, the location  
25 management agent 10 makes a decision as to an increase or decrease in the number of channels in the location registration areas #0, #1, ..., #N at the time  $(T + T_{ch})$ ,

calculates the number of the radio channels in the individual location registration areas #0, #1, ..., #N, and sends a command of the increase or decrease to the corresponding resource management agent (RMA). The  
5 individual resource management agents increase or decrease the number of channels in accordance with the command.

As a result, the number of channels of the location registration area #0 at the time ( $T + T_{ch}$ ) is reduced  
10 by one from three to two, the number of channels of the location registration area #N is also reduced by one from three to two, and the number of channels of the location registration area #1 at the time ( $T + T_{ch}$ ) is increased by two from three to five.

As described above, the present embodiment can  
15 implement the channel assignment of the individual location registration areas flexibly and effectively before the movement of the mobile stations by using the moving schedule information possessed by the location  
20 registration agent.

#### DEVELOPED EMBODIMENT

It is obvious that the object of the present invention can be accomplished by providing a system or apparatus with a recording medium (storing medium) that  
25 records a program code of software for implementing the functions of the foregoing embodiments, and by reading and executing the program code stored in the recording

medium by a computer (or CPU or MPU) of the system or apparatus. In this case, the program code itself read from the recording medium can implement the functions of the foregoing embodiments, and hence the recording  
5 medium recording the program code constitutes the present invention. As for the recording medium for recording the program code and variable data such as tables, such media as a floppy disk, hard disk, optical disk, magneto-optical disk, and nonvolatile memory  
10 card are available.

The present invention has been described in detail with respect to preferred embodiments, and it will now be apparent from the foregoing to those skilled in the art that changes and modifications may be made without  
15 departing from the invention in its broader aspects, and it is the intention, therefore, in the appended claims to cover all such changes and modifications as fall within the true spirit of the invention.